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REVIEW ARTICLE

SOME PROBLEMS AND ISSUES OF SUSTAINABLE MANAGEMENT OF MANGROVE ECOSYSTEMS OF TAMIL NADU, INDIA

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ABSTRACT

Mangrove forests, which are found along a substantial portion of the coastlines in the tropics, are fast disappearing by reclamation for aquaculture, farming, residential and industrial development and non-sustainable harvesting of timber. They play an important role in supporting tropical estuarine and coastal food webs, by providing a major source of organic material and acting as nursery grounds and habitats for commercially important fish species. For a variety of reasons relating to human activities, large areas of mangrove forests are being lost or threatened with disruption.

Mangrove, a tidal wetland, is a good example of complex land and water system whose resource attributes is neither fully understood from an ecological perspective nor valued comprehensively in economic terms. With increased ecological and social perception of the functions of wetlands, the utility and relative values will increase. The perception, however, varies from society to society. It must be recognized that mangrove forests differ greatly in local conditions and in their ability to produce a wide variety of economic products. What may be highly productive strategy for one country may have little meaning to its neighbour. Therefore, it becomes essential that from among diversity of potential uses of the mangrove environment, specific uses will have to be decided, and management plan developed on site, or area specific basis.

It is therefore necessary to arrive at a balance between the views of the ecologists and economists on the management of mangroves. Biological conservation should encompass resource management in the sense that integrity of the biological and physical attributes of the resource base should be sustained and man-induced management practices should not alter an ecosystem to the extent that biological production is eliminated. Sustained yield management for food, fiber and fuel would serve to sustain local fisheries while generating new economic enterprises. This requires the recognition of mangrove environment as a resource with economic value, and managed according to local conditions and national priorities.

Keywords: Mangrove ecosystem, Sustainable Management

INTRODUCTION

Mangroves, which are unique and impossible to substitute technologically, require a preceptive form of evaluation. The resource attributes of mangroves can be divided into two broad categories. The first can be termed pecuniary, i.e. they can be possessed, valued and exchanged within existing marketing mechanisms. The second may be terned environmental goods, which includes clean water or biological activities. The environmental goods and services such as biological production, nursery and spawning area activities of total wetlands, possess values that are as real as those of pecuniary goods. Due to poor perception of the contribution of goods and services of environmental resources of mangrove and limited dissemination of this knowledge, there is little scope for recognition of their values by a broader community. The recognition that the mangrove environment is an important resource combined with management program could lead to their conservation and integration into local and national economic development schemes.

Conservation of Mangroves

In India where there is great pressure on natural environment as a result of development can ill afford to and probably should not isolate and withhold the utilization of mangroves. However, it is just as important to prevent or minimize such lands from being simply clearing it out and putting it to other uses. Whether or not mangroves are left in the pristine state or managed for some purpose on a sustainable yield basis, the mangrove environment contributes significantly to national economics, through the fisheries they support. Absolute protection, which prohibits alternation in any manner, would imply that their social and natural values would approach infinity. Some trade-off needs to be made to strike a balance between preservation and development. It is therefore necessary to arrive at a balance between the views of the ecologists and economists on the management of mangroves. Biological conservation should encompass resource management in the sense that integrity of the biological and physical attributes of the resource base should be sustained and man-induced management practices should not alter an ecosystem to the extent that biological production is eliminated. Sustained yield management for food, fiber and fuel would serve to sustain local fisheries while generating new economic enterprises. This requires the recognition of mangrove environment as a resource with economic value, and managed according to local conditions and national priorities.

While mangroves thrive successfully because they are halophytes, efforts to develop food resources through conventional agriculture frequently lead to reduced yields and/or higher production costs, because most conventional crops are unable to adapt to such conditions. Two of the main demands of lower economic classes are for fuel and locally obtainable uses so long as the rate of removal does not exceed the rate of re-growth and replacement. Some types of environment may prove to have the highest and best use by being preserved in their natural

state and others could prove to be amenable to partial conversion for other uses.

Wetlands might be more appropriately considered in terms of their rarity or uniqueness. The relative qualitative and quantitative values of wetlands will need to be addressed if trade-off decisions are made to strike a balance between preservation and development.

In India, the West coast mangrove wetlands are small in size, less diverse, and have a simple network of tidal creeks. On the other hand, mangrove wetlands of the East coast are larger, diverse and are characterized by the presence of larger brackish water bodies and a complex network of tidal creeks and canals. This is mainly due to larger delta created by east flowing rivers and gentle sloping of the coast. Mangrove wetlands of India cover 4,87,100 ha of which nearly 56.7% (2,75,800 ha) is present along the east coast and 23.5% (1,14,700 ha) along the west coast with the remaining 19.8% (96,600 ha) in Andaman and Nicobar Islands. In most mangrove wetlands the floristic has changed dramatically, mainly due to periodicity and quantity of freshwater reaching the mangrove environment. This is especially important for river dominated mangrove wetlands since the flora of these mangrove wetlands is more susceptible to reduction in freshwater flows than tide-dominated mangrove wetlands. Any attempt at re-plantation in an attempt to restoring degraded mangrove needs to be made by taking into consideration the present conditions of the mangrove. Attempts to reintroduce *Sonneratia apetala, Xylocarpus granatum* and *Bruguiera gymnorhiza* in the Pitchavaram and Muthupet mangrove wetlands of Tamil Nadu failed because of high soil salinity (Selvam, 2003). Prevention of further reduction in freshwater inflow into the mangrove wetlands should be one of the main objectives of mangrove conservation and management plan.

Restoration efforts and its impact

Restoration of mangrove ecosystem is an important objective of coastal zone management in most countries, including India. Aforestation has been attempted as a measure of restoration of denuded mangroves that has resulted in great success. Artificial regeneration of mangrove plants by direct sowing had been undertaken very early in the last century at the Muthupet mangroves, Tamil Nadu (Azariah *et al.* 1992) but this practice was withdrawn after a few trials due to unsatisfactory results. Attempts have been made in growing mangrove seedlings in the intertidal areas of Vellar estuary, quite close to Pitchavaram mangrove along the east coast of India (Kathiresan *et al.* 1996). Similar attempts have also been made on estuarine shores at Pondicherry and Goa (personal observation).

A recent study on abundance of macrobenthos of the natural mangrove system, namely Pitchavaram (Station I), the experimentally grown mangrove in the intertidal region of the estuary (Station III) and from the estuarine area where no mangrove plants occurred (Station II) was made by Masilamani Selvam (1998). All the three areas were sampled for a period

of six months. This data was analyzed by applying ANOVA and two-dimensional MDS using PRIMER for the present interpretation. Data on substrate analysis was used to assess the sediment deposition.

The faunal composition among the three stations showed statistically significant variations between the artificially grown mangrove region of the estuary and the two natural systems (i.e. both natural mangrove and estuary). There was no statistically significant variation between fauna of the two natural systems namely the Pitchavaram mangrove and Vellar estuary (Table 1) The artificial mangrove systems, harbored a much higher faunal density, indicating that the newly created fertile environment, which probably had more food and niches has been utilized to the maximum. The two dimensional MDS configuration for the faunal abundance of the three areas shows that the three areas are quite distinct from each other (fig. 1). Therefore, it would appear that such experiments would create a new environment, which harbors fauna quite similar to that of the estuary as well as the mangrove but distinct from both. In the long run this system may reach its carrying capacity and the population density may become optimized, similar to the natural mangrove area that does not support such a high density of fauna.

An unusual amount of silt and clay deposited in this environment where artificial mangroves are grown, indicates that the accumulation of the sediment load will probably result with the elevation of the slope of the intertidal region (Fig. 2). This in turn may eventually narrow down the intertidal region and thus the area available for the organisms that normally live there. The bar across the mouth of the estuary which is generally washed away by the heavy water flow during the monsoon rains, may remain a permanent feature mainly due to reduced rainfall during the monsoon, enhanced by reduced water flow as a result of increased sediment deposition.

Destruction of the mangroves in Pitchavaram is also partly due to insufficient inundation and closing up of

Table 1 : ANOVA table for comparison of variation of faunal density among estuary, natural and artifical mangrove regions.

Source of variation	F
Among stations	29.76***
Artificial Vs natural	57.07***
Mangrove Vs estuary	2.49

F.001(2,27) = 9.00

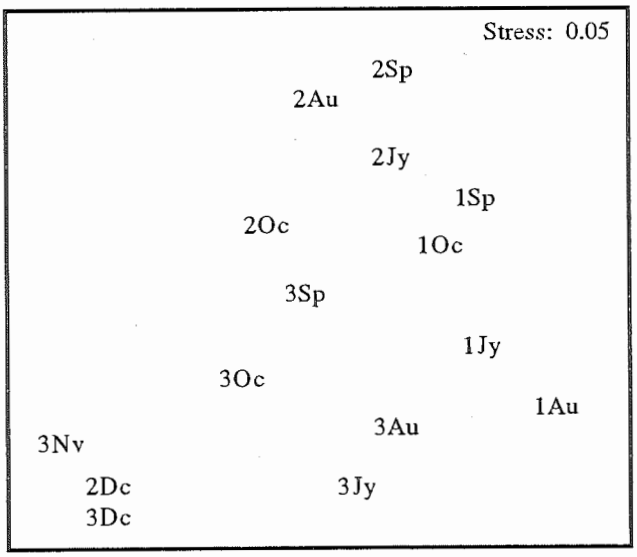

Fig. 1 : MDS plot (using Bray-Curtis similarities) for the three stations during six months of study.

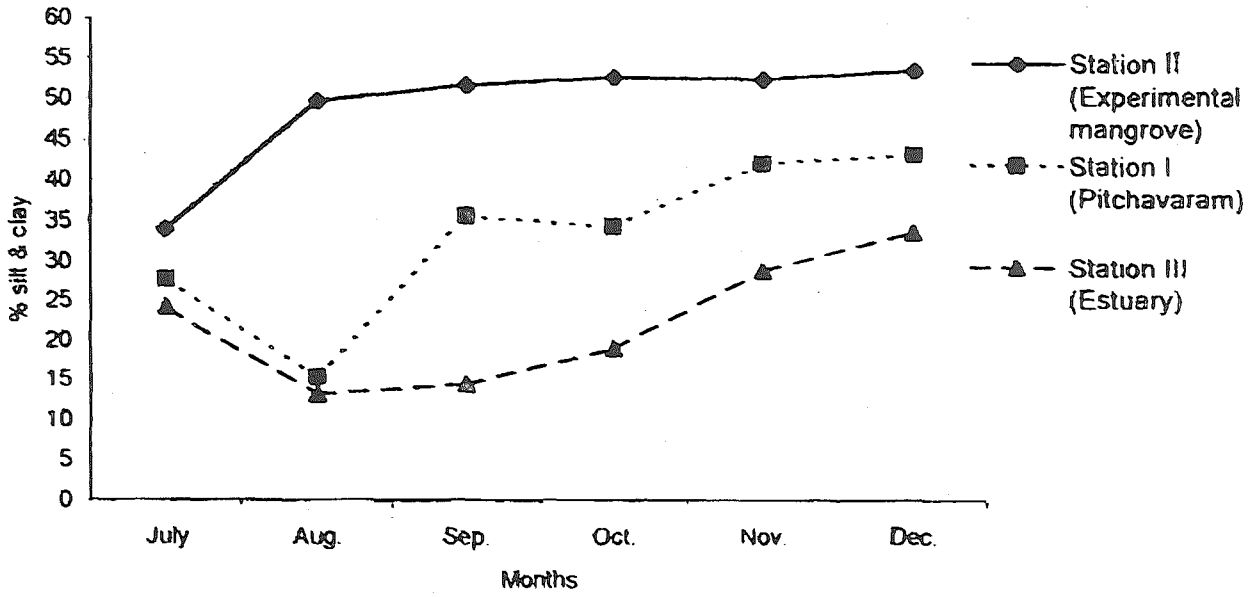

Fig. 2 : Variation in the percentage of silt & clay at the natural and experimental environments.

the channels as a result of sedimentation. In recent times this has been occurring more frequently causing loss of income to the fishermen of this area (personal discussion with the local fishermen). Earlier attempt at digging up channels in areas where the ground level was raised due to accretion of sand was discontinued after a few attempts due to high cost involved.

Kathiresan and Rajendran (2002) compared the socio-economic status of the people dependent on fishing from Pitchavaram and nearby mangrove areas. The fishery potential of the three areas compared vary in their mangrove cover. While Pitchavaram, a natural mangrove, has a plant cover of 500 ha, Vellar and Ariyankuppam have a cover of 20 and 5 ha respectively. In addition, as the mangroves of the latter two areas are artificial mangroves they differ in composition and density from that of the natural system. Therefore, it is not surprising that a much higher fishery potential was observed at Pitchavaram. No mention was made of the fishing effort in these three areas. In addition a sample of ten families from a population of 1200, 250 and 70 families from the three areas are too few to be considered as a representative sample for a socio-economic analysis.

There are several contradicting observations with regard to mangrove cover and commercial fisheries production. De Graaf and Xuan (1997) who showed some correlation between fish catches and mangroves in Vietnam suggested that the issues were complicated by significant changes in fishing effort. On the other hand Gilbert and Janssen (1997) reported a rather weak relationship between commercial fisheries production and mangrove in the Philippines. The first quantified report on mangrove cover and

fisheries from Southeast Asia made by Martosubroto and Naamin (1997) reported a positive correlation between annual catch of prawns in Indonesia and surface of mangrove. Further analysis of this data by Chansang (1977) suggested that wider the mangrove zone, the lower its productivity. Further, Robertson and Blaber (1992) reported that in spite of the constant positive relationship between mangrove and commercial fisheries, this casual link was not established experimentally. At present it has not been quantitatively proven that mangrove is the causal factor, compared to other related factors such as extensive shallow seas, intertidal area, tidal creek or length of coastline (Baran 1999).

It has also been suggested that any real statement on 'production' expressed in terms of commercial catches should integrate the number of fishing vessels and fishing effort. Besides productivity important factors like the actual dependency of fish resources on mangrove environment, the trophic and reproductive relationship with the zone, and the alternative areas for development of the species should be determined. The 2001-2002 Annual report of the Central Marine Fisheries Research Institute reported the successful release of hatchery produced post-larvae of the green tiger shrimp, *Penaeus semisulcatus* in the Gulf of Mannar as a part of a restocking program and also production of superior quality lobster larvae produced from captive brood stock. Now it appears that an answer is required for the basic question "Are mangroves a pre-requisite for prawn fisheries?" The answer to this question would help arrive at a balance between opinion of the ecologists and the economists with regard to the management of the mangroves. Further, cost benefit analysis on available data would help resolve the conflict between sustaining the ecosystem and the economic development of the mangroves.

CONCLUSION

Some critical issues with regard to conservation and management, are as follows;

- Lack of site-specific knowledge of mangrove ecology.
- Recognition of opportunities for economic non-consumptive uses of mangrove forests.
- Poor law enforcement and lack of community participation.
- Public education on the need for conservation and conservation strategies.
- Large-scale commercial exploitation against small-scale village level traditional use of mangroves.

The experience of mangrove restoration by fisherfollk and fishpond owners in some areas of Philippines showed that there was remarkably little subsequent recruitment of other non-planted mangrove species into plantations up to 50 and 60 years of age. Though important ecological and economic benefits resulted from local mangrove planting, such plantations did not help

replace a lost natural mangrove system unless a diverse mangrove plantation was undertaken (Walters, 2000). As objects of such attempts at aforestation is not very clear, it would be appropriate to consider the suggestion made by Clark (1998) who states 'A clear message has arisen from these initiative that planting should not be wasted in environments that would not naturally be colonized by mangrove'.

Thus it appears that the measures to be adopted for conserving a mangrove would depend on the objective. Attempts at establishing an artificial mangrove system, where none occurred before seems to be detrimental, and therefore it is suggested that such plantation of mangroves be restricted to the denuded area of the natural mangroves about which there is already a grave concern. In recent times it is being recognized that, mangroves that are highly regarded in most parts of the tropics for the ecosystem services they provide, also have important negative ecological and economic impacts. Some of the negative impacts are reduction in habitat quality, colonization of habitats to the detriment of native species and other aesthetic problems while positive impacts appear to be fewer (Allen, 1998). A forestation, would only help grow the kinds of plants sown and would not result in a complex mangrove system resembling the natural system and may not be useful in habitat restoration. Attempts at conservation by restricting felling alone would not help establish a mangrove ecosystem but it will also be necessary to maintain a good water flow throughout this system. As development and conservation go hand in hand it would be more fruitful, and in the interest of mankind to conserve the existing mangroves, including reestablishment by aforestation rather than attempting to establish a new mangrove where none existed before.

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